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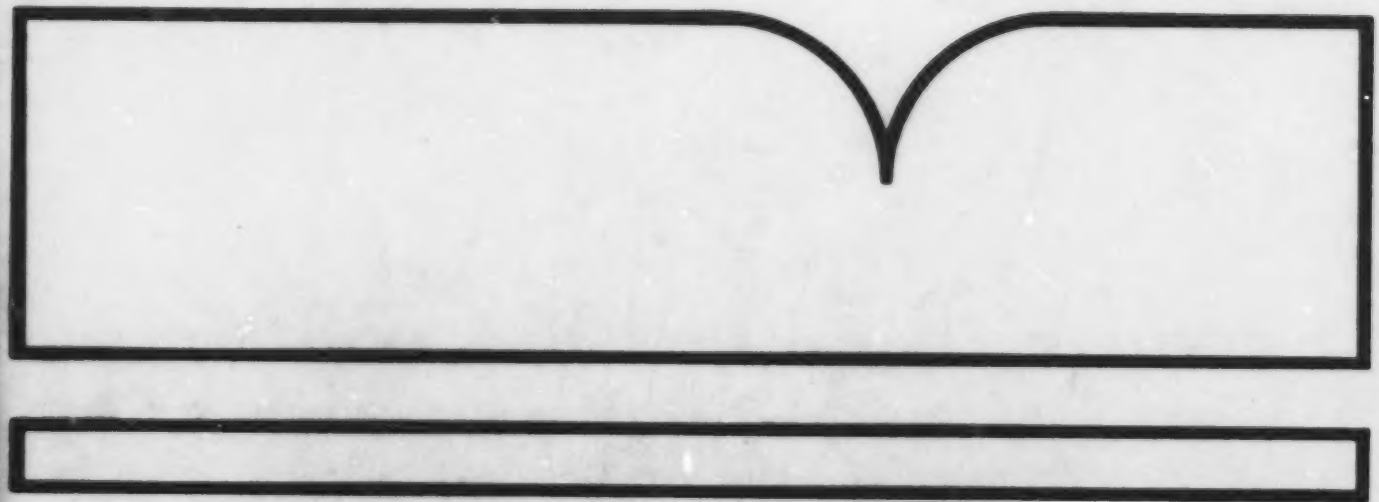

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16. ABSTRACT

In 1973, 1 to 30 million asbestos-like fibers per liter of tap water were discovered in Duluth drinking water. Previous studies had linked mesothelioma, lung, and gastrointestinal cancers with occupational exposure to asbestos, so surveillance of cancer morbidity in Duluth was initiated to investigate effects from ingestion of asbestos in drinking water. Gastrointestinal and lung cancer incidence data for 1969-1974 were collected in the same manner as in the Minneapolis-St. Paul component of the Third National Cancer Survey; Duluth rates for 1969-1971 were compared with incidence rates for the cities of Minneapolis and St. Paul during the same time period; and Duluth rates for 1972-1974 were compared with Duluth rates for 1969-1971. Duluth females and both sexes combined had statistically significantly higher rates of pancreatic cancer than in Minneapolis and St. Paul in 1969-1971. These rates subsequently decreased in 1972-1974 for both sexes combined in Duluth. Duluth males and both sexes combined had similar excesses for gastrointestinal tract not specified in comparison with Minneapolis and St. Paul. Duluth and Minneapolis cancer incidence rates yielded less-exaggerated differences between the two study areas compared with mortality rates. Resources required for morbidity surveillance are described.

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Cancer Morbidity Investigations: Lessons from the Duluth Study of Possible Effects of Asbestos in Drinking Water[1]

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In 1973, 1 to 30 million asbestos-like fibers per liter of tap water were discovered in Duluth drinking water. Previous studies had linked mesothelioma, lung, and gastrointestinal cancers with occupational exposure to asbestos, so surveillance of cancer morbidity in Duluth was initiated to investigate effects from ingestion of asbestos in drinking water. Gastrointestinal and lung cancer incidence data for 1969–1974 were collected in the same manner as in the Minneapolis–St. Paul component of the Third National Cancer Survey: Duluth rates for 1969–1971 were compared with incidence rates for the cities of Minneapolis and St. Paul during the same time period; and Duluth rates for 1972–1974 were compared with Duluth rates for 1969–1971. Duluth females and both sexes combined had statistically significantly higher rates of pancreatic cancer than in Minneapolis and St. Paul in 1969–1971. These rates subsequently decreased in 1972–1974 for both sexes combined in Duluth. Duluth males and both sexes combined had similar excesses for gastrointestinal tract not specified in comparison with Minneapolis and St. Paul. Duluth and Minneapolis cancer incidence rates yielded less-exaggerated differences between the two study areas compared with mortality rates. Resources required for morbidity surveillance are described.

INTRODUCTION

This paper discusses methodological problems in surveying cancer morbidity in a small population, in this case approximately 100,000, by comparing the study results with those obtained using mortality data only. Selected aspects of the fieldwork requirements for the morbidity survey will also be discussed.

Amphibole fibers (generically known as asbestos) were discovered in the Duluth drinking water supply in 1973. A mining company's iron ore processing plant at Silver Bay, Minnesota, 50 miles northeast of Duluth on Lake Superior, had been dumping taconite (low-grade iron ore) tailing wastes into Lake Superior since 1955. The iron ore is mined from amphibole-bearing rock, and processed into taconite pellets for shipment to steel industry locations on the Great Lakes.

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The amount of taconite wastes dumped into the lake increased in the late 1950s to approximately 67,000 tons per day and continued into 1980.

A federal court ruling has indicated that amphibole fibers in the Duluth drinking water are a result of the dumping (United States of America vs Reserve Mining Company, 5–72 Civil 19). EPA data on Duluth water samples in 1939–1940 and 1949–1950 indicate trace amounts of fibers, but samples from 1965 contain large amounts of amphibole, an average of 31% of total inorganic solids (Cook *et al.*, 1974). It is not known when amphibole fiber content increased to those levels. The 1973 water samples collected by EPA contain 1 to 30 million amphibole fibers per liter of tap water, the level generally dependent on lake weather conditions and length of time the water was in the water distribution system (Cook *et al.*, 1974). A water filtration plant in Duluth became operational in January 1977, removing 99.9% of the fibers. Monitoring of the water supply occurs daily at one of several points in the entire water distribution system. In March 1980, the mining company terminated lake dumping and began on-land disposal into a 6-square-mile tailings basin several miles from Silver Bay. A delta into Lake Superior has been created by the tailings wastes and the mining company plans to stabilize the delta with dikes and vegetation in order to prevent any further dispersion of tailings and fibers into the lake.

At the time of the discovery of fibers in Duluth water, some of the authors were involved with the Minneapolis–St. Paul component of the Third National Cancer Survey and discussed methods of studying the health effects of the asbestos exposure in the Duluth population. Obviously, we were prompted by previous epidemiologic studies indicating a link between occupational exposure and asbestosis, lung cancer, pleural and peritoneal mesothelioma, and possibly cancers of the stomach, large intestine, and rectum (Selikoff *et al.*, 1964; Enterline *et al.*, 1965; McDonald *et al.*, 1971; Enterline *et al.*, 1972; Selikoff *et al.*, 1972; Elmes and Simpson, 1971; Hammond *et al.*, 1965; Mancusso *et al.*, 1965; Selikoff *et al.*, 1974).

We decided to use the Third National Cancer Survey (TNCS) protocol to determine cancer incidence rates in Duluth, comparing them with the TNCS rates from Minneapolis and St. Paul (National Cancer Institute, 1975). It was important also, we decided, to use TNCS personnel in Duluth to assure consistency in ascertainment of cases and standardization of interpretations and rules in abstracting data. Thus cancer rates would be more comparable between geographic areas and time periods.

Duluth gastrointestinal cancer cases were first collected and analyzed for the time period 1969–1971, approximately 10 years after the initiation of heavy exposure. We have since collected data on gastrointestinal and lung cancer for 1969–1974, and are currently collecting data on cancer of all sites for 1969–1981.

Surveillance will continue throughout a sufficient time period to accommodate the length of exposure and a reasonable induction period for the development of cancer. We plan to obtain limited information from cancer cases, such as smoking and length of residency in Duluth. Surveillance has also been expanded to the entire geographic area of St. Louis County (where Duluth is located), as well as Lake and Cook Counties, because of high mortality rates for cancer in that area

and the unique environmental and occupational exposures (primarily iron ore mining) and ethnic factors in that population. Higher risks of stomach cancer, in particular, are known in Scandinavian migrants to the United States (Haenszel, 1961). Percentage of foreign born from each of the Scandinavian countries (Norway, Sweden, Denmark, Finland, Iceland) was not available from 1970 census data for the counties being studied. However, the Duluth ethnic population dominates the study area. Those data indicate that, in Duluth, 2.6% of the 1970 population were Scandinavian foreign born; in Minneapolis, 1.6%; in the state of Minnesota, 0.8%; and in the United States, 0.1%.

We present here results of comparisons of gastrointestinal and lung cancer morbidity with mortality rates and some discussion of requirements for cancer morbidity fieldwork. In particular, we compare conclusions which would be drawn using mortality data alone with conclusions to be drawn using morbidity data. We hope this may assist investigators considering the advisability of morbidity surveys around other point sources of pollution. Our results may also assist with the interpretation of the small mortality studies more commonly conducted in such areas.

METHODS

Newly diagnosed cases of gastrointestinal and lung cancer in Duluth residents were ascertained in the same manner as in the Third National Cancer Survey: patient charts and pathology and autopsy records at the three hospitals in Duluth and Mayo Clinic were primary sources, with death certificates a secondary source.

Hospital charts of cases identified from the above sources were abstracted for: name and complete identifying information of the patient, address at time of diagnosis, primary site, age, sex, race, date and place of birth, date of diagnosis, histologic type, and most definitive method of diagnosis. For the few cases identified only by death certificates and never hospitalized, we contacted relatives, attending physicians, and nursing homes, in an attempt to get the most accurate medical information possible. Addresses of all "Duluth residents" were checked with census tract guides and those who lived beyond Duluth city limits were excluded from the study. Addresses on patient charts, as on death certificates, are frequently recorded as mailing addresses or the town/city area of residence, without designation of whether or not a patient lives within the town/city limits. The determination of case residency within Duluth city limits is important for the calculation of accurate incidence rates.

Tokuhata (Governor's Fact Finding Committee, 1974) has previously noted that mortality is overreported from cities and towns and underreported in rural areas, and that this may bias conclusions drawn about mortality in a high-exposure area.

The TNCS rules provided guidelines and resolved discrepancies and uncertainties in the charts regarding the presence of cancer, primary site, histology, date and method of diagnosis, and other medical information. The definition of cancer was based on confirmatory evidence of a malignant neoplasm or, in the relatively few instances when that was not available, indication by physician's notes of a 50% or greater probability of a malignancy.

In the first phase of the study, 1969–1971, we compared Duluth cancer morbidity rates with rates in both Minneapolis and St. Paul. These were considered good comparison cities because available data indicated their water supplies were relatively free of asbestos fibers and because their populations were similar to Duluth's in age, race and ethnicity, occupational factors, and quality of medical care. Table 1 lists the population characteristics which were used to determine comparability of the cities. In the second phase of the study, Duluth rates for 1972–1974 were compared with Duluth rates for 1969–1971. The 1970 Duluth population of 100,478 decreased to an estimated 98,030 in 1973, a decline of about 2,500. Rates for both phases of the study were based on the 1970 population and were standardized to the 1970 Minnesota population.

RESULTS

Reviewing the number of incident cases found through the case-finding sources during 1969–1971, 307 (85%) cases were found from the initial source of patient

TABLE 1
CHARACTERISTICS OF POPULATION OF DULUTH AND COMPARISON CITIES[a]

	Duluth	Minneapolis	St. Paul
Total population (1970 census)	100,578	434,400	309,980
Median age			
Males	27.8	27.8	26.3
Females	31.5	30.7	29.7
Birthplace			
% Born in Minnesota	69.9	67.1	72.6
% Foreign born	5.2	4.8	3.9
% Foreign stock (foreign-born individuals + natives of foreign or mixed parentage)	27.9	23.9	21.8
Norwegian and Swedish	10.4	9.4	4.4
German and Austrian	2.5	3.4	5.2
Finnish	2.8	0.5	0.2
% White	98.3	95.6	95.4
% Who lived in same county in 1965 (as in 1970)	82.1	75.9	79.7
Median No. of school years completed (for population ≥25 years old)	12.3	12.3	12.2
% of males ≥16 years old in civilian labor force unemployed	6.0	4.2	3.6
% Families below poverty level	7.4	7.2	6.4
Median family size	3.48	3.26	3.52
Median family income	$9,313	$9,960	$10,544
% in selected occupations			
Professional, technical and kindred workers	16.4	16.5	16.5
Craftsmen, foremen, and kindred workers	13.0	10.7	11.7
Laborers except farmers	4.8	4.2	4.3
% in selected industries			
Mining	0.6	0.1	0.1
Construction	4.8	4.2	4.7
Manufacturing	16.4	20.5	25.1

[a] Based on 1970 U.S. Census data.

charts, 27 cases through review of pathology logs, 12 cases from autopsy records, and 6 cases through death certificate followback, none of which had been ascertained from the previously mentioned sources. Four additional cases were found through records at Mayo Clinic, and another 6 cases through records of the Minneapolis–St. Paul component of the Third National Cancer Survey, where data from Duluth residents hospitalized in the Minneapolis–St. Paul metropolitan area were recorded. This demonstrates the necessity of review of several types of records at various health care facilities for total case ascertainment of cancer in a population.

Average annual incidence rates are presented in Table 2 for gastrointestinal cancer and in Table 3 for lung cancer comparing Duluth with Minneapolis and St. Paul in Phase I (1969–1971) and for Duluth only in Phase II (1972–1974). (The absolute number of gastrointestinal cancers in Duluth residents for each year, 1969–1974, are presented in Table 4).

All rates are age adjusted; combined rates are also sex adjusted. Tests of significance were performed on adjusted rates, using the Mantel–Haenszel method (Mantel, 1973). Generally rates are similar between the study areas of Duluth, Minneapolis, and St. Paul. Statistically significant differences occur for pancreas and gastrointestinal tract not otherwise specified as follows: (1) for pancreas, rates for Duluth females are greater than for Minneapolis females during 1969–1971; rates for both sexes combined in Duluth are greater than in Minneapolis or St. Paul during 1969–1971; rates for both sexes combined decrease in Duluth from 1969–1971 to 1972–1974; and (2) for gastrointestinal tract not otherwise specified (GI NOS), the rates for Duluth males and both sexes combined are greater than in Minneapolis or St. Paul during 1969–1971. These rates, especially those for GI NOS, are based on small numbers and must be interpreted with caution.

Duluth lung cancer rates in Table 3 indicate a decrease in 1972–1974 from 1969–1971 for males, which is statistically significant, and a 2½-fold increase for females. These findings probably reflect changes in smoking habits and not the result of other environmental exposures. Smoking prevalence nationally among adult males has decreased from 53% in 1964 to 38% in 1978, and prevalence among adult females remains unchanged at about 30% in that time period (Public Health Service, 1979). The smoking habits in the Duluth population are not known.

Duluth data have initiated a period of long-term surveillance, which began approximately 10–15 years following the onset of exposure, and provide baseline data only for the subsequent comparison of rates through time. In our opinion, sufficient time has not elapsed to observe positive or negative associations between the exposure and cancer, and surveillance must continue for many more years in order to accommodate the length of exposure and the induction period for cancer.

Since cancer surveillance of populations is often conducted through mortality studies, we decided to compare the Duluth morbidity and mortality information in order to determine the robustness of conclusions drawn from mortality data. Population differences in survival rates, whether due to characteristics of the population or to medical care practices could conceivably obscure mortality results. Death certificate diagnoses also, of course, do not necessarily incorporate diagnostic information from medical and autopsy records abstracted in cancer

TABLE 2
GASTROINTESTINAL CANCER INCIDENCE RATES, RESIDENTS OF DULUTH AND COMPARISON CITIES 1969–1971, AND DULUTH 1972–1974

Primary gastrointestinal site	Sex	Average annual age-adjusted rates per 100,000 population[a] 1969–1971 Duluth	Mpls.	St. Paul	1972–1974 Duluth
Esophagus	Male	5.53	7.01	5.89	7.27
	Female	1.61	2.25	1.96	3.64
	Both	3.36	4.24	3.60	5.31
Stomach	Male	18.88	17.22	14.08	22.04
	Female	9.84	9.03	11.63	8.32
	Both	14.29	12.36	12.58	14.73
Small intestine	Male	3.53	2.15	1.30	2.20
	Female	1.00	1.32	0.68	0.59
	Both	2.18	1.67	0.95	1.37
Large intestine	Male	36.15	41.09	43.15	34.06
	Female	36.12	38.79	37.38	31.42
	Both	36.26	39.36	39.46	32.66
Rectum/rectosigmoid	Male	16.84	18.53	23.04	22.83
	Female	12.30	13.84	12.83	12.29
	Both	14.39	15.69	17.10	17.03
Liver	Male	3.11	3.17	2.51	2.23
	Female	1.51	0.98	2.21	1.70
	Both	2.28	1.92	2.30	1.95
Gall bladder/biliary tract	Male	2.84	3.17	4.20	2.33
	Female	5.83	3.94	5.31	6.00
	Both	4.40	3.57	4.77	4.32
Pancreas	Male	16.92	14.25	12.57	11.49
	Female	13.80	8.08[b]	9.91	8.22
	Both	15.28	10.69[c]	10.94[c]	9.74[c]
Peritoneum, retroperitoneum, and abdomen, not otherwise specified	Male	1.72	1.14	1.45	2.26
	Female	0.51	1.27	2.36	0.51
	Both	1.07	1.20	1.96	1.33
Gastrointestinal tract not otherwise specified	Male	2.84	0.28[c]	0.21[c]	0.59
	Female	1.53	0.57	0	1.56
	Both	2.16	0.45[c]	0.09[c]	1.08
Total of gastrointestinal sites	Male	108.16	108.01	108.40	107.29
	Female	84.05	80.08	84.27	74.25
	Both	95.67	91.14	93.75	89.51

[a] Male and female rates were age-adjusted; combined rates for both sexes were both age- and sex-adjusted. Rates were adjusted using the 1970 Minnesota population as the standard.
[b] Statistically significant difference with Duluth 1969–1971 at $P \leq 0.01$.
[c] Statistically significant difference with Duluth 1969–1971 at $P \leq 0.05$.

morbidity surveys (Moriyama *et al.*, 1958). The Vital Statistics Section of the Minnesota Department of Health furnished a computer listing of Duluth residents whose underlying cause of death was coded to gastrointestinal cancer. We then compared the cause of death information with morbidity data we had abstracted from hospital charts through the date of death, including any autopsy findings.

Of the 352 gastrointestinal cancer cases diagnosed during 1969–1971, 255 died during 1969–1972. For those 255 deceased cases, the following degrees of con-

TABLE 3
LUNG CANCER INCIDENCE RATES, RESIDENTS OF DULUTH AND COMPARISON CITIES 1969–1971, AND DULUTH 1972–1974

	Number and average annual adjusted rates per 100,000 population[a]					
	1969–1971				1972–1974	
	Duluth		Mpls.	St. Paul	Duluth	
Lung	Number	Rate	Rate	Rate	Number	Rate
Male	126	74.39	70.06	63.43	94	65.64[b]
Female	19	9.75	14.66	12.41	34	22.74
Both	145	39.71	38.24	34.57	128	44.50

[a] Male and female rates were age-adjusted, combined rates for both sexes were both age- and sex-adjusted. Rates were adjusted using the 1970 Minnesota population as the standard.
[b] Statistically significant difference with Duluth 1969–1971 at $P \leq 0.05$.

cordance were observed: the primary site agreed on both death certificate and abstract in 176 deaths (69%); for 20 deaths (8%), the death certificate was coded to a different gastrointestinal site than named on the abstract; for 15 (6%) deaths, the death certificate was coded to a primary site elsewhere in the body than gastrointestinal tract; cause of death for 38 cases (15%) was coded to a different disease than cancer; and 6 (2%) cases were not included on the state computer listing as deceased.

It is interesting to note the conclusions that would have been drawn had the comparison between Duluth and Minneapolis gastrointestinal and lung rates been based on mortality rather than incidence data. Table 5 presents mortality and incidence data for 1969–1971 for both Duluth and Minneapolis.

TABLE 4
NUMBER OF GASTROINTESTINAL CANCERS DIAGNOSED IN DULUTH RESIDENTS DURING 1969–1974

Site	1969	1970	1971	1972	1973	1974	Total
Esophagus	4	2	6	6	5	8	31
Stomach	17	22	14	18	17	19	107
Small intestine	2	4	2	2	1	2	13
Large intestine	38	41	54	53	28	39	253
Rectum/rectosigmoid	19	21	13	19	16	27	115
Liver	2	5	1	4	2	1	15
Gall bladder	4	7	5	5	5	6	32
Pancreas	18	22	17	13	11	12	93
Peritoneum, retroperitoneum, and abdomen, not otherwise specified	1	2	1	3	1	1	9
GI tract, not otherwise specified	3	0	5	2	1	1	12
Total	108	126	118	125	87	116	680

Three year totals
1969–1971: 352
1972–1974: 328

TABLE 5
COMPARISON OF DULUTH AND MINNEAPOLIS AVERAGE ANNUAL AGE-ADJUSTED MORBIDITY AND MORTALITY RATES PER 100,000 POPULATION FOR 1969–1971[a]

Site and code[b]	Sex	Morbidity			Mortality		
		Rate		Relative risk[c]	Rate		Relative risk[c]
		Duluth	Minneapolis		Duluth	Minneapolis	
Esophagus	M	5.5	7.0	0.79	4.2	6.1	0.69
150.0–150.9	F	1.6	2.3	0.70	1.6	2.2	0.73
Stomach	M	18.9	17.2	1.10	19.9	13.2	1.51
151.0–151.9	F	9.8	9.0	1.09	11.9	7.1	1.68
Small intestine	M	3.5	2.2	1.59	0.6	0.3	2.00
152.0–152.9	F	1.0	1.3	0.77	1.5	0.8	1.88
Large intestine	M	36.2	41.1	0.88	13.9	22.6	0.62
153.0–153.9	F	36.1	38.8	0.93	18.7	20.9	0.89
Rectum/rectosigmoid	M	16.8	18.5	0.91	9.7	6.4	1.52
154.0–154.1	F	12.3	13.8	0.89	8.8	3.0	2.93
Liver	M	3.1	3.2	0.97	1.9	2.1	0.90
155.0	F	1.5	1.0	1.50	1.0	0.8	1.25
Gall Bladder/biliary	M	2.8	3.2	0.88	1.8	2.3	0.78
tract	F	5.8	4.0	1.45	3.8	3.3	1.15
156.0–156.9							
Pancreas	M	16.9	14.3	1.18	15.4	13.5	1.14
157.0–157.9	F	13.8	8.1	1.70	11.9	7.9	1.51
Peritoneum,	M	1.7	1.1	1.55	2.3	0	2.30
retroperitoneum, abdomen, NOS	F	0.5	1.3	0.38	0.5	0.3	1.67
158.0–158.9							
Gastrointestinal tract,	M	2.8	0.3	9.33	1.1	0.3	3.67
NOS	F	1.5	0.6	2.50	1.0	0.1	10.00
159.0							
Total GI sites	M	108.2	108.0	1.00	70.7	66.7	1.06
150.0–159.9	F	84.1	80.1	1.05	60.6	46.2	1.31
Total lung	M	74.4	70.1	1.06	72.4	54.3	1.33
162.0–162.1	F	9.8	14.7	0.67	14.0	12.6	1.11

[a] Based on 1970 population and standardized to Minnesota 1970 population.
[b] *Manual of Tumor Nomenclature and Coding*, 1968 ed.
[c] Rate (Duluth)/Rate (Minneapolis).

The mortality rates in Duluth are substantially greater than mortality rates in Minneapolis for the following sites: stomach (both sexes), small intestine (both sexes), rectum/rectosigmoid (both sexes), pancreas (females), total GI sites (females), and lung (males). However, the corresponding incidence rates for both cities are quite similar.

It is useful to look at not only the absolute differences in mortality rates, but at the relative rates which are commonly used and interpreted as a "relative risk," associated with exposure. Table 5 clearly demonstrates that mortality yields more extreme relative risks (risks greater than 1.0 in either the positive or negative direction) than does morbidity. Mortality rates are more extreme in 67% (16/24) of the comparisons and in nearly all those cases, 69% (11/16) giving a positive extreme.

Incidence rates exceed mortality rates for all categories of site, sex, and city, with the exception of Duluth mortality rates which exceed incidence rates for stomach (both sexes), small intestine (females), peritoneum, retroperitoneum, abdomen, NOS (males), and total lung (females). This apparent anomaly may arise due to random variation in survivorship, exaggerated if only small numbers of deaths are involved. Also when death certificates are reviewed, for the morbidity survey, the more accurate ascription of decedent's place of residence implies the potential for inconsistency between mortality and morbidity with respect to area coded in the data bases.

Incidence rates for large intestine, rectum/rectosigmoid, and total GI sites are considerably greater than mortality rates in both cities. These latter differences reflect survivorship of cancer, and if one were attempting to determine the magnitude of the cancer problem, mortality data are somewhat appropriate.

DISCUSSION

A major point to be made regarding cancer morbidity surveillance is that a comparison area is always required. Populations exposed to pollutants tend to be small; comparison areas need to be much larger to yield a relatively stable comparison. Careful consideration must be given to the selection of a control population. The necessity for conducting surveillance anew in a control area will make the morbidity approach uneconomical or otherwise impractical, unless the morbidity data is already available and collected by a methodology very similar to that proposed for the study.

In the case of Duluth, Third National Cancer Survey data for 1969–1971 for the metropolitan area of Minneapolis–St. Paul were the comparison data. Data presented by Stebbings and Voelz (1981) at this workshop for Los Alamos County could not have been interpreted without comparable data on Albuquerque and New Mexico Anglo-whites available from the New Mexico Tumor Registry.

The existence of published cancer morbidity survey results, and the coverage of contemporaneous population-based tumor registries for a neighboring population will determine whether economical contrast possibilities exist for relevant times and places. If not, cancer morbidity surveillance may not be productive. A tumor registry area may include a potential control area and detailed coding of place of residence of cases. If so, special tabulations are likely to be available at cost.

With a control area, cancer morbidity surveillance is highly recommended. Nearly complete ascertainment of cases is readily possible. In the case of Duluth, morbidity results appear to yield more conservative substantive conclusions regarding environmental effects than mortality data. Morbidity results are also intrinsically more desirable as they, by definition, more accurately reflect cancer incidence.

The following is a discussion of the time requirements, budget, personnel, and supplies needed for conducting a study in a population of 100,000.

Before beginning the fieldwork, local medical societies, hospital administrators and medical staffs are oriented to the project and permission is obtained to abstract charts at the respective hospitals. The schedule for obtaining charts and abstracting is then established with record room administrators. This entire process may take 2–4 months.

The time requirement for abstracting charts depends on the primary site and complexity of the chart, usually 15–30 minutes per chart, 20–25 charts per day for an experienced abstractor. Usually, additional time is spent each day reviewing many charts to determine eligibility for the survey. Based on the TNCS, one would expect approximately 280 newly diagnosed cases of cancer per year in a population of 100,000. About 4 weeks are required for a nurse–abstractor to be oriented and trained for abstracting. For each year of 280 expected cases, approximately 1 month is required to abstract all cases from the primary case-finding source of medical records; 1 month to review pathology, autopsy records, and death certificates for additional cases; and 1 month for additional abstracting and related clerical work such as determining residency within city limits, and contacting physicians, nursing homes, etc., for death certificate followback. Therefore, a total of 3 months is a minimal requirement for data collection for a 1-year time period of surveillance per 100,000 population. If the abstractor is new at the job, it will take longer, and since it's reasonable to expect problems will arise which delay the project, 1–2 additional months is advised for the work outlined above.

Obviously, if there is additional data collection or interviewing of cancer cases, a full-time abstractor–interviewer is required. The hiring of a nurse (preferably someone with clinical experience) for this work is strongly recommended because of familiarity with medical terminology, disease processes, hospital systems, and the medical community. For our study, the nurse–abstractor was trained by someone from the former TNCS staff who also supervises and periodically assists with the work.

The following outlines the basic personnel and annual budget requirements (at 1979 prices) for surveillance of a population of 100,000. Recommended personnel are a full-time nurse–abstractor, salary $14,500; a supervising epidemiologist at 25% time salary $8,000; and the availability of a clerk-typist and biostatistician as needed. For surveillance of a population considerably larger than 100,000, a part-time assistant to the epidemiologist may be required for fieldwork assistance and supervision and data management. Other expenses are travel for the nurse–abstractor, $500; and for the epidemiologist to establish fieldwork procedures, orient, train, and supervise the abstractor (primarily in the first year), $1500; computer programming and services, $2000; equipment and supplies, $500, primarily for a file cabinet and printing of abstract forms.

A distinctive advantage of the project presented above was the utilization of trained personnel who have had previous experience with the same methodology, that of abstracting on the Third National Cancer Survey (TNCS). The methodology of the current SEER (Surveillance, Epidemiology, and End Results) Program of the National Cancer Institute, for the abstracting of cancer incidence data is virtually identical to that of the TNCS. In order to utilize the rigorous methodology of TNCS and SEER for cancer surveillance of a population, obtaining abstractors with that experience is strongly recommended. This eliminates the tedious and expensive task of defining and describing new methods and procedures for cancer surveillance, and since the methods are the same as a continuous program at NCI, utilization of those methods makes the data comparable with other geographic areas.

Typical problems to be encountered include: (1) imprecise or conflicting statements and evidence from physicians regarding the presence of cancer; or (2) admission of a patient to several hospitals within the study area, often with conflicting information regarding primary site and/or histology. TNCS and SEER abstracting rules resolve such problems.

Alternative appraoches would be either subcontracting the abstracting to a nearby tumor registry which is likely to be acceptable only for a very small area (10,000–20,000 population), or sending an employee to work in and be trained by that registry for 2 to 3 months. The latter is an expensive and troublesome approach, even if administratively feasible, but well worth the cost as a partial guarantee against noncomparable data.

Discussions with the staff of the nearest tumor registry are essential before initiating a cancer morbidity surveillance program. No such program should be initiated without the consultative advice and detailed program review by current experienced professional staff from the neighboring tumor registry or from a SEER-based registry. Actual audit of work performance by these experienced staff should be obtained if at all possible.

REFERENCES

American Cancer Society, Inc. (1968). "Manual of Tumor Nomenclature and Coding."

Cook, P. M., Glass, G. E., and Tucker, J. H. (1974). Asbestiform amphibole materials: Detection and measurement of high concentrations in municipal water supplies. *Science* 185, 853–855.

Elmes, P. C., and Simpson, M. J. C. (1971). Insulation workers in Belfast. 3. Mortality 1940–1966. *Brit. J. Ind. Med.* 28, 226–236.

Enterline, P. E. (1965). Mortality among asbestos products workers in the United States. *Ann. N.Y. Acad. Sci.* 132, 156–165.

Enterline, P. E., DeCoufle, P., and Henderson, V. (1972). Mortality in relation to occupational exposure in the asbestos industry. *J Occup. Med.* 14, 897–903.

Governor's Fact Finding Committe (1974). "Shippingport Nuclear Power Station: Alleged Health Effects." Report to the Governor (of the Commonwealth of Pennsylvania), Harrisburg.

Haenszel, W. (1961). Cancer mortality among the foreign born in the United States. *J. Nat. Cancer Inst.* 26, 37–132.

Hammond, E. C., Selikoff, I. J., and Churg, J. (1965). Neoplasia among insulation workers in the United States with special reference to intra-abdominal neoplasia. *Ann. N.Y. Acad. Sci.* 132, 519–525.

Mancusso, T. F. (1965). Asbestos and neoplasia; epidemiology; discussion. *Ann. N.Y. Acad. Sci.* 132, 589–594.

Mantel, N. (1973). Chi-square tests with one degree of freedom. *J. Amer. Stat. Assoc.* 58, 690–699.

McDonald, J. C., McDonald, A. D., and Gibbs, G. W. (1971). Mortality in the chrysotile asbestos mines and mills of Quebec. *Arch. Environ. Health* 22, 677–686.

Moriyama, I. M., Baum, W. S., Haenszel, W. M., and Mattison, B. F. (1958). Inquiry into diagnostic evidence supporting medical certifications of death. *Amer. J. Pub. Health* 48, 1376–1387.

National Cancer Institute (1975). "Third National Cancer Survey: Incidence Data," DHEW Publication No. (NIH) 75-787. U.S. Govt. Printing Office, Washington, D.C.

Public Health Service (1979). "Smoking and Health: A Report of the Surgeon General," DHEW Publication No. (PHS) 79-50066. U.S. Govt. Printing Office, Washington, D.C.

Selikoff, I. J., Churg, J., and Hammond, E. C. (1964). Asbestos exposure and neoplasia. *J. Amer. Med. Assoc.* 188, 22–26.

Selikoff, I. J., Hammond, E. C., and Churg, J. (1972). Carcinogenicity of amosite asbestos. *Arch. Environ. Health* 25, 183–186.

Selikoff, I. J., Hammond, E. C., and Seidman, H. (1974). Cancer risk of insulation workers in the United States. *Insulation Hygiene Progress Reports* 6, 1–8.

Stebbings, J. H., and Voelz, G. L. (1981). Morbidity and mortality in Los Alamos County, New Mexico. I. Methodological issues and preliminary results. *Environ. Res.* 25, 86–105.

DISCUSSION

Unidentified: Have you observed any mesotheliomas in Duluth?

E. Sigurdson: Yes, we have observed one-half to one case per year of pleural mesothelioma in a recent 9-year time period. That is the frequency expected based on the TNCS rates. One case of peritoneal mesothelioma has occurred during that period.

S. Brown: Other studies have indicated synergy or multiplicative risk of asbestos and smoking and the recent thesis at Berkeley found a positive relationship between gastrointestinal cancer and asbestos in drinking water. Also there is some evidence that smoking increases the risk of gastrointestinal cancer. Because of these findings and because of the literature showing associations between iron ore mining, smoking, and lung cancer, I think that smoking histories should be obtained from the cancer cases, or a sample, in your three-county study area. Also I'm concerned about the differences in smoking habits between that area and Minneapolis.

E. Sigurdson: Yes, we hope to obtain smoking histories, and we do record smoking on our abstract form if the physician has recorded it in the hospital chart. Age- and sex-adjusted mortality rates by county for the state of Minnesota indicate our study area has some of the highest mortality rates in the state for lung cancer, bronchitis, and emphysema. We recognize this probably reflects smoking habits, and I believe the lifestyle of the people involves heavier smoking than elsewhere in the state.